California Medicine
THE WESTERN JOURNAL OF MEDICINE

The Prevention of Residual Biliary Calculi

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■ *Residual calculi following cholecystectomy may be expected in approximately seven percent of cases. The vast majority of these are overlooked during operation; truly re-formed stones are rare.*

Calculi are missed during cholecystectomy because of failure to explore the common bile duct. This is due to (1) the presence of silent choledochal stones, and (2) reliance on negative cystic duct cholangiograms in the presence of indications for common duct exploration.

Overlooking of silent stones during cholecystectomy may be prevented by routine operative cholangiography. Ideally, false-negative cystic duct cholangiograms should be eliminated by the use of fluoroscopic cholangiography.

Retained calculi following duct exploration may be prevented by (a) routine biliary endoscopy and (b) completion fluoroscopic cholangiography.

Re-formation of ductal calculi can probably be prevented by appropriate biliary drainage procedures performed during the initial choledochotomy. Selection of patients for primary biliary decompression remains an experimental problem.

THE SURGICAL CURE OF BILIARY LITHIASIS requires removal of all calculi in the biliary tract and the correction of factors which may lead to recurrence. Both the overlooking of calculi at the time of cholecystectomy, whether or not the common duct is opened, and the new formation of calculi in the bile ducts after operation may be prevented by the utilization of advances in instrumentation and in choledochal operative techniques.

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Submitted revised, June 11, 1970.

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Incidence

Retained Calculi Following Cholecystectomy

The probability of overlooking stones in the bile ducts at the time of cholecystectomy may be estimated by considering errors in the usual procedural sequence. If there are no indications for choledochotomy, operative cholangiography is generally not done. Yet when it has been done in such circumstances, "unsuspected" calculi have been found in 4 percent[1-15] representing 2.4 percent of all cholecystectomies (Table 1). In patients with classical indications for common duct

TABLE 1.—*Potential Sources of Retained Calculi**

Group	Percent of Cholecystectomies	Retained Stones: Percent of Group	Retained Stones: Percent of Cholecystectomies
CHOLECYSTECTOMY, no indication for choledochotomy.....	60	4	2.4
CHOLECYSTECTOMY, indication for choledochotomy. NEGATIVE OPERATIVE CHOLANGIOGRAM, no choledochotomy.....	25	10	2.5
CHOLECYSTECTOMY, CHOLEDOCHOTOMY, completion cholangiogram	15	8	1.2
			Total: 6.1

*From Jolly[12]

exploration, choledochotomy is now commonly done if cystic duct cholangiograms are positive or suspicious. In patients whose ducts are not opened because cholangiograms show no abnormality, an error of approximately 10 percent has been shown by deliberate choledochotomy.[5,12-16] This represents an over-all error of 2.5 percent for all patients undergoing cholecystectomy (Table 1). Adding this error of false negative cholangiograms to the incidence of silent calculi detected by routine cholangiography, one can calculate that stones are retained in the bile ducts in 4.9 percent of patients undergoing cholecystectomy as commonly practiced.

Residual Calculi Following Cholecystectomy And Choledochotomy

Retained. Overlooked stones are found by postoperative cholangiogram in approximately 20 percent of patients when choledocholithotomy is done without operative cholangiography (Table 2). The addition of completion cholangiograms reduces this incidence by approximately 50 percent. The best results reported[17,21] probably reflect individual ability resulting from extensive experience in biliary operations, rather than any specific benefit of the procedures utilized.

Re-formed. There is little doubt that calculi can re-form in the bile ducts. This diagnosis can be made when large stones are removed several years following common duct exploration in patients with normal postoperative T-tube cholangiograms. Characteristically, the calculi differ morphologically from those found at the primary operation, being soft, non-faceted, with no central nidus and of an "earth-like"[26] consistency. The frequent detection of co-existing lesions interfering with biliary drainage further strengthens the conviction that these are re-formed calculi.[26] Based on these criteria, the incidence of re-formed calculi after choledochotomy appears to be 4 percent.[18,19] This represents only 1 percent of all patients undergoing cholecystectomy.

The potential for residual (retained plus re-formed) calculi thus amounts to 7 percent of all cholecystectomies. This coincides with the reported incidence of residual calculi found in patients with the "post-cholecystectomy syndrome."[28] It should be emphasized that in the majority of patients with residual biliary calculi the common duct was not explored at the primary operation.

Reports indicate that from 30 percent to 83 percent of patients with retained calculi will become symptomatic, the majority requiring re-operation within the follow-up period.[4,17,18] Recurrence following re-operation exceeds that of primary operation, in addition to high morbidity and mortality rates. It therefore behooves the surgeon to make every effort to rid the biliary tract of calculi during the initial operation.

Prevention

Retained Calculi Following Cholecystectomy

Routine operative cholangiography. Operative cholangiography is by far the most valuable tool for the prevention of retained calculi. Objections to it on grounds of increased operating time and inaccuracy are readily dispelled as experience is gained with routine application.[1-3,6-12,14,16,17] Reports repeatedly indicate progressive improvement in results at a given institution with time and experience. Furthermore, the availability of a permanent record of common duct size at the time of cholecystectomy may be of inestimable value for comparison with future cholangiograms, in the event of post-cholecystectomy complaints.

The value of completion cholangiography fol-

TABLE 2.—*Incidence of Retained Biliary Calculi following Primary Choledocholithotomy Detected by Post-Operative Cholangiogram*

Author	Date of Report	No. of Choledocho-lithotomies	Completion Operative Cholangiogram	Biliary Endoscopy	Retained Calculi Percent of Choledocho-lithotomies	Mean Percent
Havard	1960	84	None	None	24	
Hicken[17]	1964	486	None	None	19	20
Johnston[18]	1954	153	Some	None	8	
Smith[4]	1957	123	Some	None	11	
Smith[20]	1963	166	Some	None	14	7
Colcock[21]	1964	139	Some	None	2	
Hight[5]	1959	77	All	None	9	
Hicken*[17]	1964	407	All	None	4	
Hicken**	1964	400	All	None	11	8
Fogarty***	1968	84	All	None	8	
Wildegans[22]	1960	143	All	All	3	
Schein[23]	1969	43	All	All	0	
Shore[24]	1969	100	Most	All	3	3
Weichel[25]	1969	233	All	All	3	

*Author's personal series
**Hospital Survey
***Calculated from published data

lowing common duct exploration is generally accepted. Routine use of this procedure will lead to discovery of stones missed by exploration in approximately 10 percent of choledocholithotomies, thus reducing the incidence of retained stones by 50 percent (Table 2). However, this represents only 1.2 percent of patients undergoing cholecystectomy, since the duct is usually explored in only 15 percent of the cases. Routine operative cholangiography, the value of which is still questioned, regularly leads to the discovery of unsuspected calculi in 2.4 percent of patients undergoing cholecystectomy (Table 1). The advisability of performing an operative cholangiogram during every cholecystectomy is thus apparent.

Operative cholangiography with television-fluoroscopy. The classical indications for common duct exploration usually lead to unnecessary choledochotomy in more than 50 percent of cases. In recent years, several investigators have attempted to increase selectivity by the use of operative cholangiography.[5,12,15,17,18] While this has decidedly reduced the incidence of negative explorations, reliance on negative operative cholangiograms in patients with clinical indications for explorations has been associated with a false-negative incidence of approximately 10 percent. Letton[10] demonstrated that this source of error can be eliminated by an improved technique based on double contrast. Other approaches to increased cholangiographic accuracy involve the application of the image-intensifier to operative radiology.[30,31] Appropriately designed operating tables, such as the Kifa, permit the use of a mobile image-intensifier with television monitor and a 70 x 70 mm roll-film camera, such as the Siemens. Operative cholangiography with this equipment incorporates the advantages of fluoroscopy and spot film technique, high resolution and improved communication between surgeon and radiologist.

Retained Calculi Following Choledochotomy

Completion cholangiography with television-fluoroscopy. Completion cholangiography as currently performed is associated with an 8 percent error (Table 2). It is expected that the use of this new technique, when applied to post-exploration cholangiography, will eliminate false-negative interpretation as a reason for leaving stones. While preliminary reports with this technique have been encouraging,[31] a statistical evaluation is yet to be done. The value of routine fluoroscopic operative cholangiography is currently under study at this institution. A higher degree of correlation between radiologic and surgical findings is expected.

Biliary endoscopy. In 1889, Thornton, performing the third recorded choledochotomy, inserted a Ferguson speculum into the distal common duct in order to visualize the ampulla of Vater.[26] In the intervening years, a variety of biliary endoscopes designed for this purpose have been described. None received wide ac-

TABLE 3.—*Contributions of Biliary Endoscopy to Operation*

Detection of overlooked calculi		22 percent
Aid to operation		6 percent
Assisted in removal of calculi	2	
Assisted in operative decision	4	
Aid to interpretation of cholangiogram		7 percent
Evaluation of "non-emptying"	1	
Evaluation of filling defect	6	

ceptance until the Wildegans rigid choledochoscope appeared in 1953.[22] Clinical experience with instruments of this type, mainly in Europe, brought enthusiastic reports. In this country, however, technical problems associated with the rigid construction have limited widespread adoption.[32] Dissatisfaction with the Wildegans endoscope led to the development of the flexible fiberoptic choledochoscope. The design, technique and results of clinical experience with this instrument have been recently reported elsewhere.[24]

Biliary endoscopy is performed through the choledochotomy incision following completion of choledochal exploration but before completion cholangiography. The interior of the biliary tract, from the ampulla of Vater to the secondary divisions of the hepatic ducts can be clearly visualized. Calculi missed by conventional instrumental manipulation are readily detected and removed following endoscopy. Routine choledochoscopy led to the detection of such overlooked calculi in 22 percent of 100 consecutive cases of primary choledocholithotomy (Table 3) while failing to discover all biliary calculi in an additional 3 percent.[24] Similar results have been reported by other investigators (Table 2).

This combination of advanced technology in both operative radiology and endoscopy of the biliary tract will virtually eliminate the problem of the retained stone following choledochotomy.

Other instruments. Several instruments designed to improve the results of choledochotomy have been recently devised. The Fogarty biliary catheter is an extremely useful tool for operative evaluation of the distal common duct and ampulla, in addition to the removal of ductal calculi. Its accuracy, however, is no greater than that achieved by operative cholangiography alone (Table 2). The ultrasonic probe, first described by Thurston and Kirby and recently revived by Eisman,[33] has similarly failed to surpass

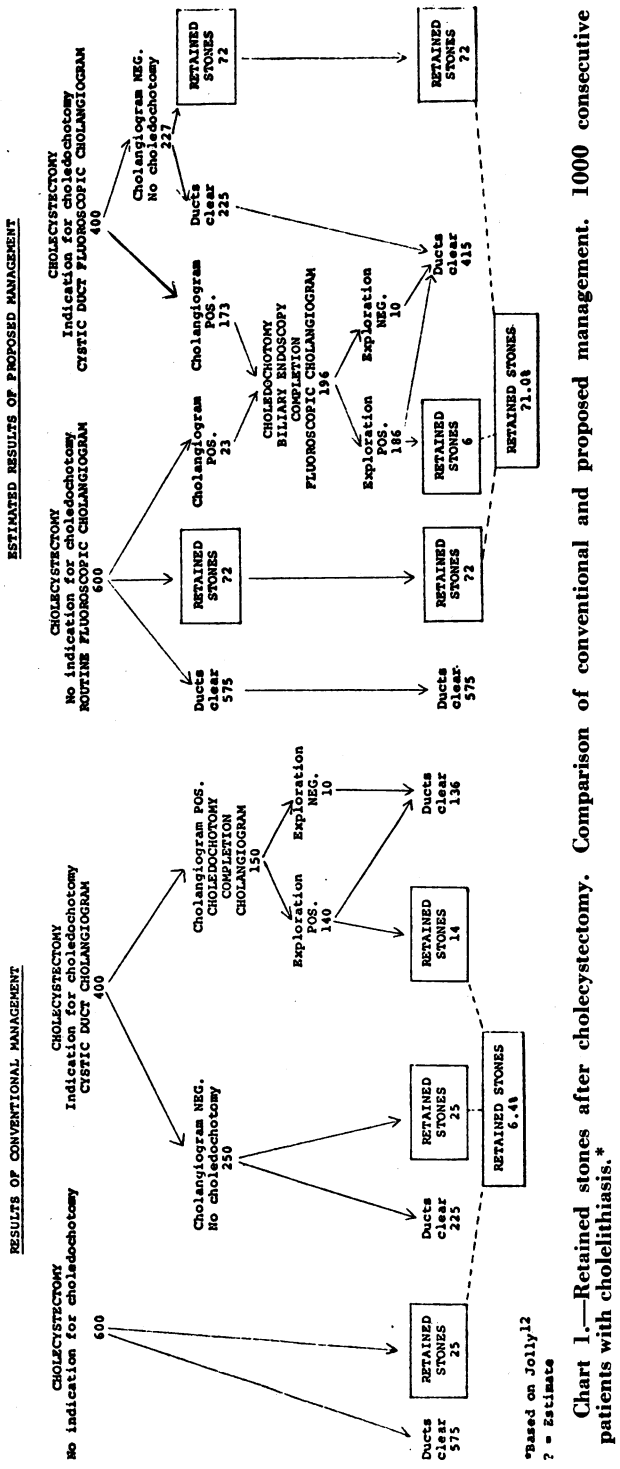

Chart 1.—Retained stones after cholecystectomy. Comparison of conventional and proposed management. 1000 consecutive patients with cholelithiasis.*

the results obtained by operative cholangiography. The Glassman brushes, although based on very sound principles of choledocholithotomy, are of value only in the distal common bile duct. Furthermore, their application makes duodenotomy mandatory in every case.

TABLE 4.—*Results of Procedures to Prevent Re-formed Calculi*

Procedure	Reported by	Date	No. Cases	Mortality (percent)	Failure (percent)	Follow-Up (percent)	Years (Range)	Mean
Sphincteroplasty	Jones	1969	139	1	1	?	(½ to 15)	5
Choledocho-duodenostomy	Hurwitz	1964	40	2	2	94	(½ to 8)	
	Hess	1965	92	1	1	60	(2 to 6)	
	Madden	1968	50	1	4	85	(1 to 16)	7
Sphincterotomy	Hess	1965	73	5	3	75	(2 to 6)	
Hepatic Plexus Vagotomy	Schein	1969	15	0	Too early to evaluate			

Chart 1 compares results achieved by conventional management with those expected from the proposed methods. A six-fold decrease in the incidence of retained stones is anticipated. The use of routine fluoroscopic cholangiography should detect choledochal calculi usually overlooked during cholecystectomy, leading to choledochotomy in these patients. Retained stones will be found, then, mainly in patients whose ducts are not completely cleared following choledocholithotomy. This can be reduced to a minimum by routine biliary endoscopy and completion fluoroscopic cholangiography (Table 2).

Re-formed Calculi Following Choledochotomy

Biliary stasis is generally recognized as the underlying cause of re-formed calculi. When at the time of choledocholithotomy this is found to be due to a specific lesion, such as chronic pancreatitis, the need for a concomitant biliary drainage procedure is apparent. In many cases, however, the existence of biliary stasis is merely suggested by such findings as biliary mud, multiple calculi, pronounced dilatation of the duct, "primary" common duct stones,[26] or increased resistance to sphincter cannulation. In these circumstances, the addition of a primary biliary drainage procedure has been advocated to prevent re-formation of calculi.[27,34,35] While this has been accomplished with an acceptable mortality rate and favorable end results (Table 4), the relatively broad indications employed probably lead to excessive application. Furthermore, correlation between these indications and recurrence has not been documented by long-term studies.

The possibility of detecting potentially recurrent cases by more objective criteria has been evaluated by several investigators.[27,35,37] Elevated passage pressures, as determined by operative biliary manometry, have been suggested as an indication for corrective procedures.[36,37] Jacobson[38] and others, however, found no correlation between manometric findings and clinical results. Their conclusions may be questioned, since they failed to assess pressure determinations by radiomanometry. Berci,[39] utilizing such studies, has shown that passage pressures recorded only by manometry may not be reliable determinants of outflow resistance.

The use of operative cholangiography with television-fluoroscopy will permit the documentation of valid passage pressures at operation as well as postoperatively. These findings can then be compared with long-term clinical evaluation. Correlation between increased outflow resistance and clinical recurrence could then identify cases requiring primary permanent biliary decompression. The prevention of re-formed stones thus remains an experimental problem.

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PREOPERATIVE SYSTEMIC ANTIBIOTICS IN CHRONIC ULCERATIVE COLITIS

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"Our present choice of antibiotics in the patient with an infected colon is Keflin®. We give 2 grams every six hours, a total of 8 grams a day, 'piggy-back' intravenously beginning about 24 hours before surgery. To this we usually add ampicillin, 500 mg four times a day intramuscularly, again beginning the day before surgery. Ampicillin covers the range of anaerobes that Keflin misses. There are alternate programs. Some people use large doses—20 to 30 million units—of penicillin and I have no objection to this. . . . We have found Keflin uniquely free of side-effects, particularly as far as the kidney is concerned; and we have found ampicillin to be an extremely helpful adjunct."

—F. WARREN NUGENT, M.D., Boston

Extracted from *Audio-Digest Surgery*, Vol. 16, No. 15, in the Audio-Digest Foundation's subscription series of tape-recorded programs. For subscription information: 619 S. Westlake Ave., Los Angeles, Ca. 90057.